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Diploma Programme
Programme du diplôme
Programa del Diploma

Physics
Standard level
Paper 1

25 April 2024

Zone A afternoon | **Zone B** afternoon | **Zone C** afternoon

45 minutes

Instructions to candidates

- Do not open this examination paper until instructed to do so.
- Answer all the questions.
- For each question, choose the answer you consider to be the best and indicate your choice on the answer sheet provided.
- A clean copy of the **physics data booklet** is required for this paper.
- The maximum mark for this examination paper is **[30 marks]**.

2224 – 6704

14 pages

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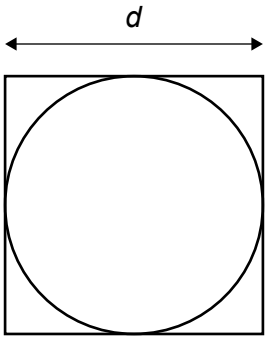
1. The diameter of a particular circle is equal to the length of the side of a square. The length of one side of the square is $d \pm \Delta d$.



The area of the circle is $\pi \times \frac{d^2}{4}$.

What is the $\frac{\text{fractional uncertainty in the area of the square}}{\text{fractional uncertainty in the area of the circle}}$?

A. $\frac{4}{\pi}$

B. 1

C. $\frac{\pi}{4}$

D. $\frac{1}{2}$

2. Which distance is the longest?

A. 10^{-18} Gm

B. 10^{-13} km

C. 10^{-2} μm

D. 10^{-1} fm

3. When a horizontal spring is stretched, the force exerted by the spring is directly proportional to its extension.

The energy transferred to a spring to extend it by a distance x is *E.*

What work is done by the spring when the extension is reduced by $\frac{x}{3}$?

A. $\frac{2E}{9}$

B. $\frac{E}{3}$

C. $\frac{4E}{9}$

D. $\frac{5E}{9}$

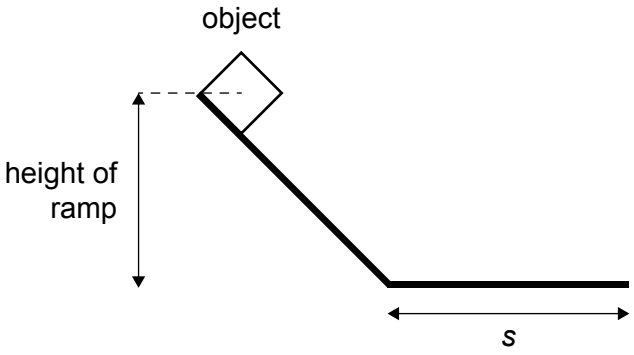
4. An object is launched upwards at an initial velocity $+u$ at an angle of θ to the horizontal. Air resistance is negligible.

At a later time the object has a vertical displacement of zero.

What are the horizontal component of the velocity and the vertical component of the velocity at this later time?

	Horizontal component of the velocity	**Vertical component of the velocity**
A.	$u\cos\theta$	$u\sin\theta$
B.	$u\cos\theta$	$-u\sin\theta$
C.	$u\sin\theta$	$u\cos\theta$
D.	$u\sin\theta$	$-u\cos\theta$

5. An object is released from rest and slides down a frictionless ramp. The object then leaves the ramp and slides along a rough horizontal surface. The object stops in a distance *s* along the ramp.



The coefficient of dynamic friction between the object and the rough horizontal surface is μ.

What is the height of the ramp?

A. $\mu g s$

B. $\frac{s}{2g\mu}$

C. $\frac{s}{\mu}$

D. μs

6. An object with mass *m* falls through the air with a terminal speed *v* for a short time *t*.

What is the work done on the air by the falling object during this time?

A. $mgvt$

B. mgt

C. $\frac{mgv}{t}$

D. $\frac{mv}{t}$

7. An electric motor has an energy of 1.8 kJ transferred to it in 0.50 minutes. The efficiency of the motor is 40 %.

What is the useful power output of the motor?

A. 1.5 W

B. 24 W

C. 150 W

D. 360 W

8. An object of mass m is accelerated from rest by a constant resultant force F.

The final velocity of the object is v.

What energy is transferred to the object during the acceleration?

A. $\frac{Fv}{2}$

B. Fv

C. $\frac{mv^2}{2}$

D. mv^2

9. An object of mass 0.30 kg is travelling in a straight line. An impulse acting on the object changes its velocity from 25 cm s^{-1} to 5.0 cm s^{-1}.

What is the magnitude of the impulse?

A. 0.06 N s

B. 0.09 N s

C. 6.0 N s

D. 9.0 N s

10. An assumption of the kinetic model of an ideal gas is that each gas particle

A. has the same speed as all the others.

B. collides elastically with the container walls.

C. travels parallel to the container walls.

D. has a momentum that does not change.

11. Two containers X and Y are filled with the same ideal gas and connected by a tube of negligible volume. The volume of X is twice the volume of Y.

X is held at a temperature of 150 K and Y is held at a temperature of 300 K.

What is $\frac{\text{mass of gas in X}}{\text{mass of gas in Y}}$?

A. $\frac{1}{4}$

B. 1

C. 2

D. 4

12. A solar panel transfers energy at a rate of 2.4 kW to a liquid passing through it. The liquid has a specific heat capacity 4000 $J\,kg^{-1}\,K^{-1}$. The temperature of the liquid increases by 6.0 K when it flows through the solar panel.

What is the flow rate of the liquid through the panel?

A. $0.1\,g\,s^{-1}$

B. $0.1\,kg\,s^{-1}$

C. $10\,kg\,s^{-1}$

D. $100\,kg\,s^{-1}$

13. An object is undergoing simple harmonic motion.

For this object, what is the phase difference between the variation of displacement with time and the variation of acceleration with time?

A. 0

B. $\frac{\pi}{4}$ rad

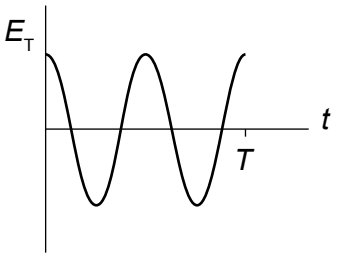
C. $\frac{\pi}{2}$ rad

D. π rad

14. A simple harmonic oscillation has a time period T.

What is the variation with time t of the total energy E_T of the oscillation?

A.



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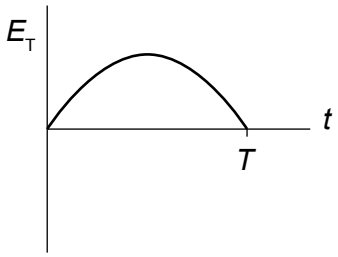

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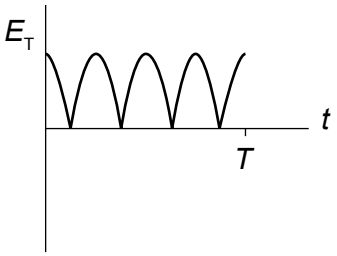

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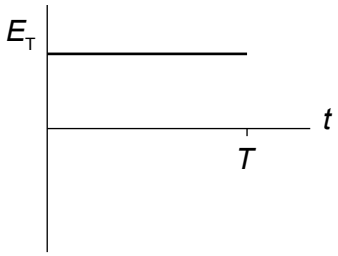


15. A vibrating string is fixed at both ends. The frequency of the second harmonic of a stationary wave generated on the string is 240 Hz.

What is the frequency of the fifth harmonic?

A. 96 Hz

B. 360 Hz

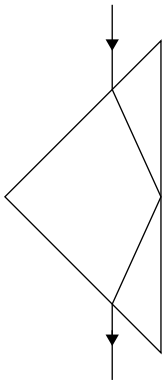
C. 600 Hz

D. 1200 Hz

16. A glass prism has internal angles 45°, 45° and 90°. The glass has a critical angle of 45°.

What is a possible path of light through the prism?

A.



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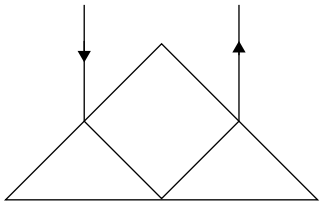

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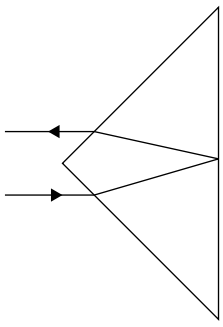

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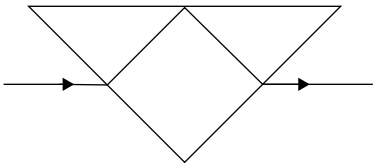


17. A point source of light of amplitude Y is viewed from a distance x. The observed light intensity is I.

The amplitude is now decreased and the distance changed to $\frac{x}{2}$. The observed light intensity becomes $2I$.

What is the new amplitude of the source?

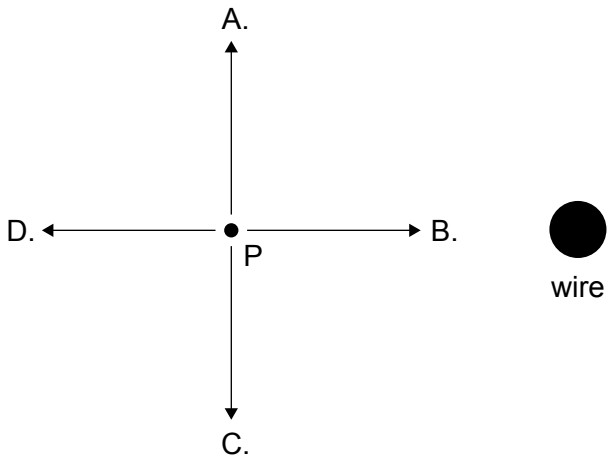
A. $\frac{Y}{8}$

B. $\frac{Y}{4}$

C. $\frac{\sqrt{2}}{4}Y$

D. $\frac{\sqrt{2}}{2}Y$

18. Electrons are moving in a long wire that is normal to the plane of the paper. The electrons move into the paper.



What is the direction of the magnetic field at point P?

19. What is a possible unit of electrical resistance?

A. WA^{-2}

B. AV^{-1}

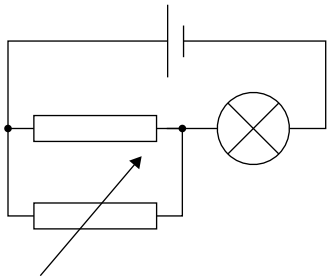
C. VW^{-2}

D. WV^{-2}

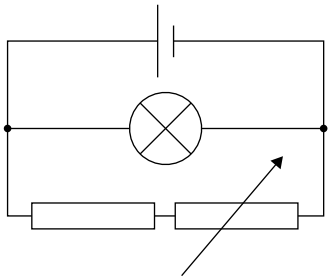
20. Four circuits are available for an electrical experiment. The internal resistance of the cell in each circuit is negligible.

In which circuit can the current in the lamp be varied by adjusting the variable resistor?

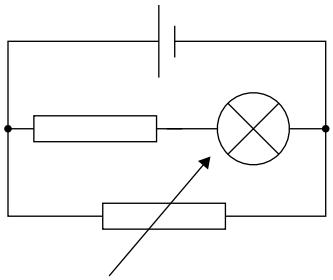
A.



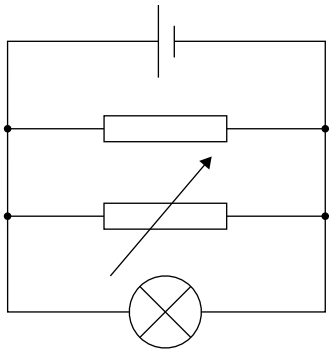
B.



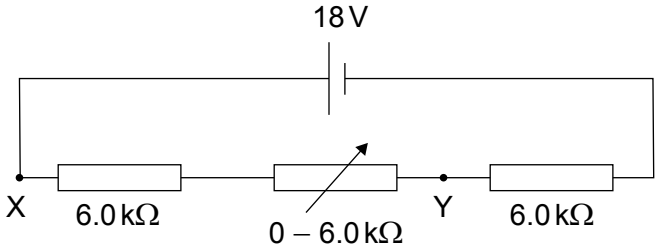
C.



D.



21. A variable resistor with a resistance range of 0 to 6.0 kΩ is connected in series with two resistors of fixed value 6.0 kΩ. The cell in the circuit has an emf of 18 V and a negligible internal resistance.



What is the maximum range of potential difference that can be observed between X and Y?

A. 0 to 12 V

B. 6.0 V to 9.0 V

C. 9.0 V to 12 V

D. 9.0 V to 18 V

22. An object of mass *m* is attached to the end of a rope. The object is rotated in a horizontal circle at the end of the rope with an increasing speed. The rope breaks when the angular velocity ω is reached.

At what other combination of mass and angular velocity will this rope break?

	Mass	Angular velocity
A.	3*m*	$\frac{\omega}{2}$
B.	4*m*	$\frac{\omega}{4}$
C.	3*m*	$\frac{\omega}{4}$
D.	4*m*	$\frac{\omega}{2}$

23. Planet X has a mass *M* and radius *R* with gravitational field strength *g* at its surface. Planet Y has mass 3*M* and radius 2*R*.

What is the gravitational field strength at the surface of planet Y?

A. $\frac{2g}{3}$

B. $\frac{3g}{4}$

C. $\frac{4g}{3}$

D. $\frac{3g}{2}$

24. What are three fundamental forces listed in decreasing order of strength?

A. Strong nuclear, gravity, electromagnetic

B. Electromagnetic, strong nuclear, gravity

C. Strong nuclear, electromagnetic, gravity

D. Gravity, weak nuclear, electromagnetic

25. Which equation is an example of β^+ decay?

A. $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + \mathrm{e}^- + \nu_\mathrm{e}$

B. $^{14}_{6}\mathrm{C} \rightarrow {}^{14}_{7}\mathrm{N} + \mathrm{e}^+ + \bar{\nu}_\mathrm{e}$

C. $^{23}_{12}\mathrm{Mg} \rightarrow {}^{23}_{11}\mathrm{Na} + \mathrm{e}^+ + \bar{\nu}_\mathrm{e}$

D. $^{23}_{12}\mathrm{Mg} \rightarrow {}^{23}_{11}\mathrm{Na} + \mathrm{e}^+ + \nu_\mathrm{e}$

26. The half-life of a radioactive nuclide is 15 minutes. The initial count rate observed from a pure source of the radioactive nuclide is 580 counts s^{-1}.

The average background count rate is 20 counts s^{-1}. The decay products are stable.

What is the observed count rate one hour after the initial observation?

A. 35 count s^{-1}

B. 55 count s^{-1}

C. 70 count s^{-1}

D. 90 count s^{-1}

27. Which particle, at rest, has the largest magnitude for $\frac{\text{charge}}{\text{mass}}$?

A. Alpha particle

B. Beta minus particle

C. Proton

D. Neutron

28. Three changes that may affect the climate are:

I. Increasing the capture of carbon dioxide and then storing it

II. Changing the fuel of power stations from natural gas to Uranium-235

III. Changing the fuel of power stations from natural gas to oil

Which changes are likely to **reduce** the enhanced greenhouse effect?

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

29. The power emitted by a spherical black body at absolute temperature T is P.

The absolute temperature of the black body is halved and its radius is doubled so that the power emitted becomes P'.

What is $\frac{P'}{P}$?

A. $\frac{1}{16}$

B. $\frac{1}{8}$

C. $\frac{1}{4}$

D. $\frac{1}{2}$

30. The average albedo of a surface is 0.40.

What is $\frac{\text{power reflected by the surface}}{\text{power absorbed by the surface}}$?

A. 0.40

B. 0.60

C. 0.67

D. 1.5